April 16
Victor Roytburd
Rensselaer Polytechnic Institute

Propagation of Electromagnetic Pulses in Doubly-Resonant Optical Media

Over the last few years there have been exciting achievements in designing artificial optical materials (metamaterials) with very unusual properties. For example, in some frequency regimes, they may be "left-handed" (with the left-oriented triplet of the electric, magnetic, and wave vector) and even have a negative refractive index. The experimental realization of the left-handed property is based on the resonant response of the artificial material to both electric and magnetic fields. I will discuss our recent results on propagation of extremely short electromagnetic pulses for a simple model of homogeneous doubly-resonant media, where the Duffing oscillators (anharmonic oscillators with cubic nonlinearities) represent the dielectric response of the medium, and the harmonic oscillators represent the magnetic response. The model possesses a one-parameter family of traveling-wave solutions with the structure of single or multiple humps. Rather unexpectedly, the spectrum of velocities contains a sizable discrete component. The traveling-wave solutions are found to be linearly neutrally stable. Numerical simulations demonstrate that the traveling-wave pulses behave very much like solitons: they collide in a nearly elastic fashion.